Oregon Non-Residential Building Energy Code

OREGON DEPARTMENT OF ENERGY

Roofs

Roofs are one way that heat is gained or lost through the building envelope to the outdoors. The Oregon Energy Code's prescriptive standard requires that either the nominal R-value of the insulation or the U-factor of the roof assembly meets minimum requirements.

Prescriptive Approach

The simplest way to comply with the prescriptive approach is to use insulation with a minimum R-value of R-19. A 2x6 wood framed roof with batt insulation that fills the entire cavity will meet the prescriptive requirement. Continuous insulation with a minimum R-value of R-19 will also meet the prescriptive requirement (in fact, using continuous insulation will improve thermal performance).

U-factor Calculation

If the insulation R-value doesn't meet or exceed R-19, then calculate the U-factor of the assembly.

The U-factor calculation is performed on Worksheet 3b of the compliance documentation (this worksheet is not required to be completed if insulation R-value is used to demonstrate compliance).

The first step is to determine the effective R-value of the various components of the roof. Table 3a provides effective R-values for a variety of roof framing and insulation assemblies, including wood framing, metal framing, and metal trusses. Table 3b gives insulation R-values of other common components of the roof assembly (such as gypsum board ceiling.) Table 3d gives the R-values of air layers next to the interior and exterior surface of the roof. The inverse of the total R-value is the U-factor for the assembly. If the calculated U-factor exceeds 0.050, you will need additional insulation to meet the prescriptive requirement. The following figure is an example of a typical U-factor calculation for a roof taken from Worksheet 3b of the energy code compliance forms.

Roof Assembly 1 - ID Flat Roof Over Gym

	(a) Layer	(b) Description	(c) Detail	(d) R-value
	Exterior	Moving Air		0.17
	A	Roofing	Roofing built-up	0.33
	B	Rigid Insulation	Cellular polyisocyanurate 1" unfaced, 1.5 lb/ft3	5.56
	C	Roof/Floor Framing/Insulati	Roof/Floor Engineered Wood Comp. I-Beam 48" o.c. R-13	12.70
	D	Interior Finish	Hardwood Maple 1"	0.66
	I			
	J			
	Interior	Still Air		0.61
	1. Total column (d)			20.25

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Code Language

1312.1.1 Air leakage. Penetrations or through openings in the building envelope that are potential sources of air leakage shall be caulked, gasketed, or weatherstripped, or otherwise sealed to limit infiltration and exfiltration.

Doors and operable glazing separating conditioned from unconditioned spaces shall be weatherstripped. Fixed windows and sash in operable windows shall be tightfitting with glass retained by stops with a continuous air seal.

Exception: Openings required to be fire resistant. Building assemblies used as ducts or plenums shall be sealed, caulked and gasketed to limit air leakage.

Exterior joints around windows and door frames, between wall cavities and window or door frames, between wall and foundation, between wall and roof, between wall panels, at penetrations or utility services through walls, floors and roofs and all other openings in the exterior envelope shall be sealed in a manner approved by the building official.

1312.1.2 Insulation materials and installation. All insulation materials shall be installed according to the manufacturer's instructions to achieve proper densities, maintain clearances and maintain uniform R-values. Access to equipment shall be provided which prevents damaging or compressing the insulation. Refer to section 1312.2 for performance requirements.

To the maximum extent possible, insulation of the required R-value shall extend over the full component area.

Exception: Access doors and hatches from conditioned spaces to unconditioned spaces.

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Documentation: To document compliance with this section of code, fill out Compliance Form 3a.

In addition:

- **Prescriptive Approach:** Form 3b with the appropriate associated worksheets.
- **Simplified Trade-Off Approach:** Submit a disk with the CodeComp file on it. This file can be found in the GDT\CodeComp\ Project directory with an .occ file extension.
- **Whole Building Design Approach:** Call Oregon Dept. of Energy for information on complying via the Whole Building Design Approach.

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1312.1.2.1 Suspended ceilings. Suspended ceilings shall not be used to separate conditioned spaces from unconditioned spaces.

1312.1.2.2 Recessed light fixtures. Recessed light fixtures shall not be installed in ceilings separating conditioned from unconditioned spaces.

Exception: Fixtures designed and labeled as suitable for being installed in direct contact with insulation (i.e., IC rated)

1312.1.4 Moisture control. A 1-perm vapor retarder shall be installed on the warm side (in winter) in all exterior floors, walls and ceilings of heated buildings.

Exceptions:

1. Masonry walls with exposed interior surfaces. Slab-on-grade floors need not have a warm-side vapor barrier.
2. The building official may require designed moisture control systems for refrigerated buildings, buildings convering swimming pools or similar buildings with unusual potential for moisture damage.
3. The building official may accept designed moisture control systems which may include vapor barriers, ventilation, dehumidification or combinations thereof.

A ground cover shall be installed in the crawl space for both new and existing buildings when insulation is installed. Ground cover shall be 6-mil black polyethylene or other approved material of equivalent perm rating. Ground cover shall be lapped 12 inches (305 mm) at all joints and over the entire surface area extending full width and length of the crawl space.

1312.2 Thermal performance. All heated or mechanically cooled buildings and structures, or portions thereof, shall be constructed so as to provide the required thermal performance of the various components as set forth in this subsection.

Exception: Glazing up to 1 percent of the exterior wall area is exempt from the U-factor and shading coefficient requirements of this code.

Buildings shall comply by using either Section 1312.2.1 or 1312.2.2.

1312.3.1 Additions. Additions shall meet all requirements that apply to new buildings.

Exceptions:

1. Additions of the same use and occupancy classification as the existing building which increase floor area up to 10 percent of the existing building area, not to exceed 1,000 square feet (93 m^2), if the component U-factors, including glazing, are equal to or less than corresponding U-factors in the existing building.

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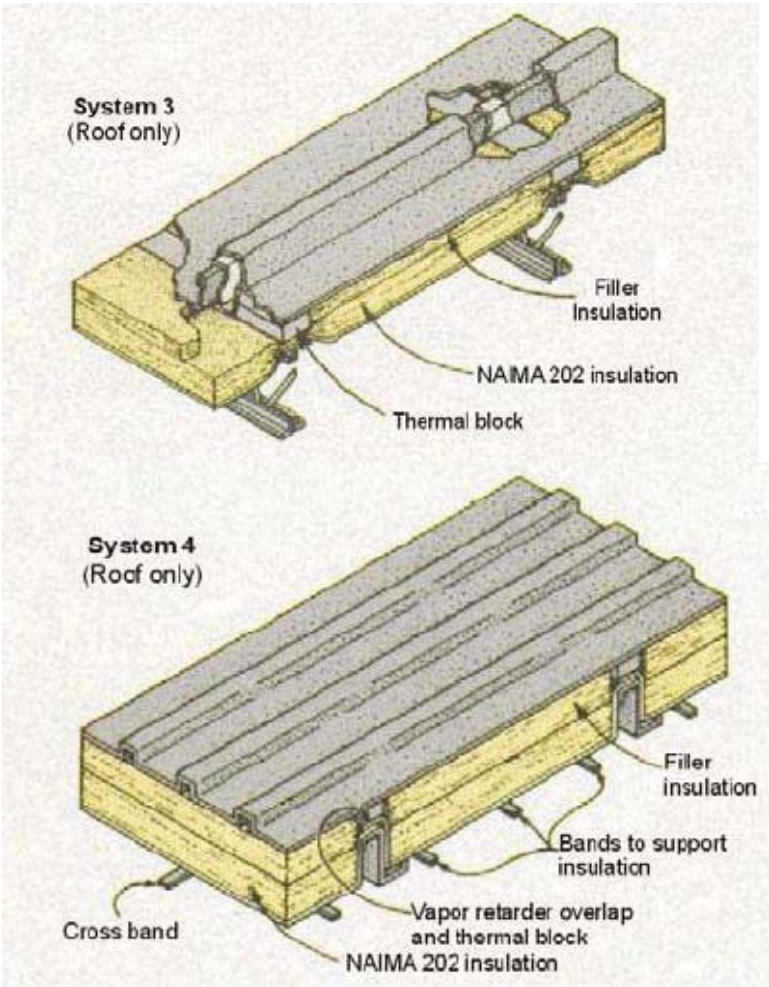
Providing continuous insulation is an effective way to improve thermal performance. It also can serve as an air barrier and vapor barrier. Common types of continuous insulation include expanded polystyrene foam (bead board) or polyisocyanurate foam. "Polyiso" foam has a higher R-value per inch of thickness than polystyrene foam, but its performance deteriorates over time more rapidly.

Metal Framed Roofs and Metal Buildings

While metal framed rafter or attic roofs may comply with prescriptive insulation R-value requirements, they would require additional insulation to meet the prescriptive U-factor requirement. In addition to batt insulation installed between the rafters, the assembly will typically include continuous rigid insulation at the ceiling or rigid foam thermal block material over the steel framing.

There are several insulation options for metal building roofs. The North American Insulation Manufacturers Association (NAIMA) provides information on insulation types and representative U-factors. Although the use of R-19 NAIMA-202 insulation will meet the prescriptive requirement, the installation method affects thermal performance. When possible, use a system that avoids compression of the insulation at the framing members and includes rigid foam thermal blocks at the framing members. The insulation can be installed either on top of and perpendicular to the framing



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members, or between the metal purlins. The placement of rigid foam thermal blocks on top of the purlins will prevent thermal bridging across framing members. Default U-factors for metal building roof assembly are found in Table 3c of the Non-Residential Energy Code compliance manual.

Other Compliance Options

In most cases, the roof assembly should meet the prescriptive requirement. However, if neither the insulation R-value nor the U-factor meet the requirement, the simplified tradeoff method may be used to demonstrate compliance (see the Envelope Compliance Methods fact sheet for more information).

Moisture Control

Oregon code requires a vapor retarder to be installed on the "winter warm" side of the roof assembly. For all Oregon climates this is the interior of the assembly. Materials with a low permeance rating (generally lower than 1 perm) (57 ng/s-m^2-Pa), are considered vapor retarders. Vapor retarders can either be film materials such as asphalt coated kraft paper, aluminum foil or polyethylene sheet, or closed-cell insulation materials such as extruded polystyrene. Asphalt coated kraft paper, asphalt-impregnated felt, are both wood-based materials and perform very differently than foil and polyethylene. While the performance of polyethylene and foil in resisting vapor diffusion is independent of the relative humidity of the surrounding air, wood-based materials such as kraft paper, asphalt-impregnated felt, and oriented strand board increase their perm rating with an increase in the humidity of the adjacent air. This allows more water vapor to pass through the material, allowing increased drying when needed.

New synthetic materials, resistant to mold and rot, have been formulated to perform in a similar way and are called "smart" vapor retarders. These new materials are specially formulated to act as vapor retarders when the RH drops indoors in the winter, yet allow drying through them during warm, humid outdoor conditions.

Suspended Ceilings

As outlined in Section 1312.1.2.1, Oregon code does not allow suspended ceilings "to be used to separate conditioned spaces from unconditioned spaces." In other words, batt insulation on a suspended ceiling cannot be used to create the thermal envelope of the building. This is because air moves relatively freely from a room to a space above a suspended ceiling. Insulation above suspended ceiling tiles is often moved around and not replaced as tiles are moved for access to the space above the ceiling. Insulation can be placed on the tiles for sound attenuation purposes, but if it is, code minimum insulation must also be placed at the roof.

Demising Surfaces

In Oregon code, demising surfaces are defined as, "A building element consisting of walls, windows, doors, floors, or ceilings that

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2. Additions which have glazing areas and/or skylight areas exceeding the maximum allowed under the prescriptive path and meet all of the following requirements:
   - 2.1 The maximum height of the addition shall not exceed 20 feet (6.1 m^2) measured from the ground floor.
   - 2.2 The maximum floor area of the addition shall not exceed 3,000 square feet (279 m^2) or 15 percent of the existing building ground floor area, whichever is less.
   - 2.3 The center-of-glass U-factor shall not exceed 0.30, tested or calculated on the vertical plane,
   - 2.4 The shading coefficient for overhead glazing shall not exceed 0.40, the shading coefficient for vertical glazing shall not exceed 0.57,
   - 2.5 At least 25 percent of the gross area of the exterior wall of the addition shall have a U-factor not to exceed 0.13 in Zone 1 and 0.09 in Zone 2, and
   - 2.6 Any opaque roof/ceiling portions shall have a U-factor not to exceed 0.05 or an insulation value not less than R-19.

Examples

Q I have a wood-framed 2x4 rafter roof, with only R-13 batt insulation. Can I still use the prescriptive compliance method?

A Only if the U-factor does not exceed 0.050. From Table 3A of the compliance manual, a 2x4 wood-framed roof, with framing 24" o.c and R-13 insulation, the effective R-value of the framing with insulation is 9.36. A continuous insulation with an R-value of R-10 or greater will meet the prescriptive U-factor requirement:

$$R_{roof} = R_{(exterior\ air\ resistance)} + R_{(framing/insulation)} + R_{(continuous\ insulation)} + R_{(Interior\ air\ res)}$$
$$= 0.17 + 9.36 + 10 + 0.61 = 20.14$$
$$U_{roof} = 1/R_{roof} = 1 / 20.14 = 0.0497$$

Adding rigid insulation having an R-value of 6 or greater will comply with the prescriptive R-value requirement:

R-13 batt insulation + R-6 rigid insulation = Total R-19 insulation.

Q My building has a cool roof. Can I get credit for using this technology?

A No. While code does not provide any credit for a cool roof, it may still be beneficial to use this system.

Examples

Q I am replacing a leaky roof membrane. The rigid insulation will be exposed when I remove the leaky membrane, and is only R-10. Do I need to add insulation to bring it up to current code requirements (R-19)?

A Yes, alterations to existing roofs must meet current code requirements. An exception to this requirement is if the existing insulation is not exposed by the re-roofing project (for instance when insulation is below roof deck).

Q I am installing rigid insulation on my roof that will be sloped to allow proper drainage. The insulation at its thickest point is equivalent to R-25 and at its thinnest R-15. It averages out to R-20. Does this comply since the average is greater than the R-19 prescriptive minimum?

A No. Prescriptive R-values are minimum values. If the roof insulation is sloped it must be R-19 at its thinnest point.

Q My building has a metal building roof. R-19 insulation is installed between the purlins so as not to compress the insulation. According to Table 3C, the U-factor for this assembly is 0.079. Does this assembly still meet the prescriptive requirement?

A Yes. Even though the calculated U-factor is higher than 0.050, since R-19 insulation is installed, the assembly complies.

Find Out More

Copies of code:

Oregon Building Officials Association
phone: 503-873-1157 fax: 503-373-9389

Technical Support:

Oregon Department of Energy
625 Marion Street NE phone: 503-378-4040
Salem, OR 97301-3737 toll free: 800-221-8035
www.oregon.gov/energy fax: 503-373-7806

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Northwest Energy Efficiency Alliance
www.nwalliance.org

Photo on page 1 c/o Warren Gretz, DOE/NREL

12/05 ODOE CF-125/Fact Sheet 6

Non-residential code ENVELOPE fact sheets include:

- Envelope Compliance Approaches
- Fenestration Performance
- Walls
- Roofs

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separates conditioned space from either unconditioned or semi-conditioned space(s)."

Oregon code requires that demising elements are treated the same as exterior walls, and must meet building envelope requirements according to Section 1312.1.

Additions

Additions must meet the same requirements as a new building with a few exceptions. Small additions are one exception to this rule. Specifically, your addition is exempt if it is:

- 10% or less the size of the existing building (no more than 1,000 ft^2),
- of the same use/occupancy, and
- with U-factors equal to or less than the existing building.

Alterations

Alterations must comply with the requirements of the code.

If you open up a roof, you must ventilate it according to Section 1203.2 and insulate it according to Tables 13-E and 13-F. If a roof alteration exposes the roof insulation, it must be brought up to current code requirements.